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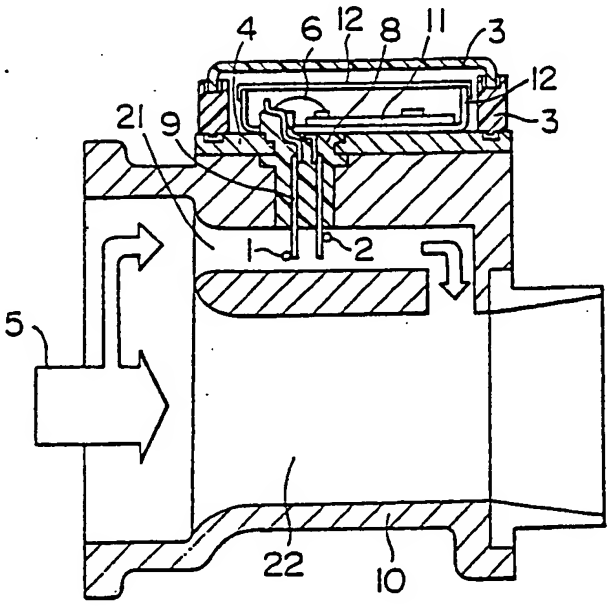
(54) Thermal air flow meter.

(57) A thermal air flow meter for measuring the flow rate of intake air supplied to an internal combustion engine comprises a thermal sensor (1) disposed in an intake air passage (21), a drive circuit (11) including a circuit pattern formed on a circuit board for driving the thermal sensor, a shielding case (12) having at least a bottom wall on which the circuit board is mounted and side walls, a through capcitor (15) disposed on one of the side walls of the shielding case, a conductor (13) extending through the capacitor so that the conductor is electrically connected in an AC mode through the capacitor to the shielding case and having one end connected to a corresponding terminal of the drive circuit and the other end connected to an external terminal, a metal case (4) in which the shielding case is mounted and a connecting member (16; 17, 25; 18; 19; 20) electrically connecting the shielding case to the metal case at an area on the bottom wall selected between an edge of the bottom wall connected to the one side wall and an edge of the pattern formed on the circuit board closest to the one side wall, whereby the endurance electromagnetic compatibility of the air flow m ter is improved.

FIG. 1



EP 0 323 694 A2

THERMAL AIR FLOW METER

BACKGROUND OF THE INVENTION

FIELD OF THE INVENTION

This invention relates to a hot wire type air flow meter, and more particularly to an air flow meter which is suitable for measuring the flow rate of air supplied to an internal combustion engine and which operates with an excellent endurance electromagnetic compatibility.

DESCRIPTION OF THE RELATED ART

A hot wire type flow meter is disclosed in, for example, Japanese patent unexamined publication JP-A-58-6414. In the prior art hot wire type flow meter, thrcugh-capacitors are fixed to conductor leading openings respectively of a shielding case of an electrical conductive material accommodating a drive circuit which drives a flow rate sensor, and power supply and signal output conductors, to be connected to the drive circuit are extended into the shielding case through the respective through-capacitors thereby preventing the drive circuit from being disturbed by outside noises.

In the prior art flow meter described above, the power supply and signal output conductors connected to the drive circuit driving the flow rate sensor are electrically connected in an AC mode through the capacitors to the shielding case. However, no consideration is given in the prior art flow meter as to electrically connecting the conductive shielding case to a flow meter case in which the shielding case is mounted and the shielding case is merely fixed to the flow meter case by an adhesive. Therefore, the shielding case could not always be fixed to the flow meter case in a relation accurately positioned relative to the latter, and, because the former was not electrically connected to the latter, the endurance electromagnetic compatibility of the flow meter has been quite low.

SUMMARY OF THE INVENTION

It is an object of the present invention to provide a thermal air flow meter in which through capacitors, through which conductors connecting a drive circuit to a positiv terminal and a negative terminal of a power supply and through which an output signal line extends, ar electrically connected to a material at a specific predetermined position so as to improve the endurance electromagnetic compatibility of the air flow meter.

According to the present invention which attains the above object, the conductors and the output signal line described above extend through the through capacitors which are electrically connected in an AC mode through the through-capacitors to a shielding case of an electrical conductive material accommodating the drive circuit, and the shielding case is brought into electrical contact with the conductive flow meter case at a specific area which is determined as follows. That is, a circuit board formed with a circuit pattern constituting the drive circuit is attached to a bottom wall of the shield case and the through capacitors are fixed to one of the side walls of the shield case connected to the bottom wall. The specific area is selected within an area on the bottom wall corresponding to the area between an edge of the circuit pattern closest to the one side wall and an edge of the bottom wall connected to the one side wall.

In an embodiment of the thermal air flow meter according to the present invention, signal terminals connected to an external wiring harness to receive power supplied to a drive circuit and to transmit an output signal from the drive circuit are connected to the drive circuit by electrical conductive members or wires extending through associated through capacitors fixed to a shielding case of an electrical conductive material. The through capacitors are electrically connected in an AC mode through the capacitors to the shielding case, to a bottom wall of which a circuit board having a circuit pattern constituting the drive circuit is fixed. The shielding case is brought into electrical contact with a flow meter case of an electrical conductive material at a selected area as mentioned above. With this arrangement, electrical noise generated from the external wiring harness under influence of radio wave can be earthed through the through capacitors to the flow meter case or to an air intake body defining an intake air passage, before the electrical noise is transmitted to the drive circuit of the hot wire type air flow meter. Therefore, the drive circuit can be shielded against the adverse effect of the radio wave, and the endurance electromagnetic compatibility of the air flow meter can be improved.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a schematic sectional view of an embodiment of the hot wire type air flow meter of the present invention when its sensor is disposed in a bypass air passage.

Fig. 2 is a view similar to Fig. 1 to show its sensor disposed in a main air passage.

Figs. 3 and 4 are a schematic plan view and a schematic sectional view respectively of the parts including the drive circuit of the hot wire type air flow meter shown in Fig. 1.

Figs. 5 to 9 are schematic sectional views showing various manners of grounding the shielding case to the base of the flow meter case.

Fig. 10 is a graph showing the results of the endurance electromagnetic compatibility test of the air flow rate sensor.

Figs. 11 and 12 are a schematic plan view and a schematic sectional view respectively of a trial-manufactured model of the air flow meter of the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Preferred embodiments of the present invention will now be described with reference to the drawings.

Fig. 1 is a schematic sectional view of an embodiment of the hot wire type air flow meter of the present invention designed for measuring the flow rate of intake air of an internal combustion engine.

Referring to Fig. 1, the air flow meter includes a hot wire 1 made by winding a filament of platinum around a bobbin of alumina and coating a surface covering of a glass material. This hot wire 1 is welded to exposed portions of a pair of supporting pins 9 inserted into a supporting member 8 of an electrical insulator supporting a base 4 of a flow meter case of an electrical conductive material. A cold wire 2 of an electrical resistor similar to the hot wire 1 is provided for the purpose of compensation of the temperature of intake air and is similarly welded to exposed portions of supporting pins 9 inserted into the supporting member 8. The supporting pins 9 are electrically connected to a drive circuit 11 through a wiring 6 of aluminum. The drive circuit 11 is fixed by an adhesive to a shielding case 12 of an electrical conductive material, and the shielding case 12 is also fixed by an adhesive to the base 4 of the flow meter case. A molded case 3 molded on the base 4 covers the shielding case 12 and associated parts.

The hot wire type air flow meter including the drive circuit 11 and the hot and cold wires 1 and 2 welded to the supporting pins 9 is mounted on an air intake body 10 in which a bypass air passage 21 and a main air passage 22 are formed. When the air flow meter is mounted on the air intake body 10, the hot and cold wires 1 and 2 are located in the bypass air passage 21. The drive circuit 11 supplies current to the hot wire 1 to heat the hot wire 1 so that the difference between the temperature of the hot wire 1 and that of intake air flow 5 is maintained constant regardless of the quantity of intake air flow 5, while the temperature variation of intake air flow 5 is detected and compensated by using a cold wire 2. Therefore, when the flow rate of air flowing through the bypass air passage 21 is high, a large current is supplied to the hot wire 1, while when the flow rate of air is low, a small current is supplied to the hot wire 1, so that the temperature difference can be maintained constant. The relation between the value of current supplied to the hot wire 1 and the flow rate of intake air flow 5 is expressed by a monotone increasing function. Thus, by detecting the value of current supplied to the hot wire 1, the flow rate of intake air flow 5 can be detected.

Fig. 2 shows an arrangement in which the hot wire type air flow meter described with reference to Fig. 1 is mounted on an air intake body 10 having a single air passage.

Figs. 3 and 4 are a schematic plan view and a schematic sectional view respectively of the hot wire type air flow meter described with reference to Fig. 1. Referring to Figs. 3 and 4, signal terminals 13 connectable with an external wiring harness are connected to the power line 26, grounding line 27 and signal line 28 of the drive circuit 11 by wires 14 of an electrical conductive material respectively, and the wires 14 extend through respective through capacitors 15 which are electrically connected to the shielding case 12. Further, the shielding case 12 is electrically connected to the base 4 at a specific area 23 which is determined as follows. That is, a circuit board 11 formed with a circuit pattern constituting the drive circuit is attached to a bottom wall of the shield case and the through capacitors 15 are fixed to one of the side walls of the shield case 12 connected to the bottom wall. The specific area 23 is selected within an area on the bottom wall corresponding to the area between as edge of the circuit pattern closest to the one side wall and an edge of the bottom wall connected to the one side wall.

Fig. 10 is a graph showing the results of the endurance electromagnetic compatibility test of a trial-manufactured model of the hot wire type air flow meter of the present invention. Figs. 11 and 12 are a schematic plan view and a schematic sectional view respectively of the trial-manufactured model of the air flow meter. The characteristic curve a shown in Fig. 10 represents the results of the endurance electromagnetic compatibility test

when the shielding case 12 and the base 4 are entirely electrically isolated from each other. The characteristic curve b shown in Fig. 10 represents the endurance electromagnetic compatibility when a cup 24 press-fitted into the base 4 is welded to the shielding case 12 at a point 25, and the shielding case 12 is partly press-fitted on a pin 17 erected on the base 4 so as to provide spaced two electrical connection points at the outside of the array of the through capacitors 15 mounted on the shielding case 12 and also when the shielding case 12 is locally electrically isolated from the base 4 in an area 26 lying immediately beneath the drive circuit 11, as shown in Figs. 11 and 12. Further, the characteristic curve c shown in Fig. 10 represents the endurance electromagnetic compatibility when the shielding case 12 and the base 4 are entirely electrically brought into contact with each other. It will be seen from Fig. 10 that the present invention can provide the endurance electromagnetic compatibility of the level equivalent to the case where the shielding case 12 and the base 4 are extirely electrically brought into contact with each other.

Figs. 5 to 9 show various manners of grounding the shielding case 12 to the base 4. Fig. 5 shows that the shielding case 12 and the base 4 are electrically connected to each other by a screw 16 of an electrical conductive material. Fig. 6 shows that the pin 17 of an electrical conductive material is press-fitted into the base 4, and the shielding case 12 is previously formed with a mating hole to be press-fitted on the pin 17. Fig. 7 shows that, after a pin 18 of an electrical conductive material is press-fitted into the base 4, the shielding case 12 is electrically connected to the base 4 by caulking the head of the pin 18. Fig. 8 shows that a projection 19 is formed as part of the base 4 by means of, for example, a press, and the shielding case 12 is press-fitted to this projection 19. Fig. 9 shows that the shielding case 12 and the base 4 are electrically connected to each other by an electrical conductive adhesive 20.

In the hot wire type air flow meter described above, the present invention specifies the range where the shielding case 12 enclosing the drive circuit 11 is electrically connected to the base 4 of the flow meter case. More precisely, the signal terminals 13 connected to the external wiring harness are connected to the drive circuit 11 by the wires 14 extending through the through capacitors 15 which are electrically connected to the shielding cas 12 accommodating the drive circuit 11. Further, the shielding case 12 is brought into electrical contact with the base 4 of the flow meter case in a portion of the area 23 which lies nearly immediately beneath the through capacitors 15 and which is outside of the conductors printed on the circuit board on which the drive circuit 11 is formed. Therefore, the air flow meter can be shielded from external electrical noise, and the endurance electromagnetic compatibility can be greatly improved without regard to the factors including the thickness of the adhesive layer fixing the shielding case 12 to the base 4 of the flow meter case.

Further, when the manner of joining the shielding case 12 to the base 4 as shown in any one of Figs. 5 to 8 is applied to a plurality of spaced points, the shielding case 12 can be easily accurately positioned relative to the base 4, and the manufacturing accuracy can be greatly improved.

It will be understood from the foregoing description that the present invention provides a hot wire type air flow meter in which a shielding casing accommodating a drive circuit is electrically connected to a base of a flow meter case in a portion of an area which lies nearly immediately beneath through capacitors mounted on the shielding case and which is outside of conductors printed on a circuit board on which the drive circuit is formed. Therefore, the endurance electromagnetic compatibility of the air flow meter can be greatly improved without regard to the thickness of an adhesive layer used for fixing the shielding case to the base.

Claims

1. A thermal air flow meter comprising:

(a) a drive circuit (11) driving a thermal sensor (1) disposed in an intake air passage (21) through which an air to be measured flows and including a circuit pattern formed on a circuit board;

(b) a shielding case (12) having a bottom wall on which said circuit board is fixed and side walls connected to respective edges of said bottom wall;

(c) capacitor means including at least one capacitor (15) and fixed to one of said side walls;

(d) a metal case (4) mounting therein said shielding case;

(e) at least one conductor (13) having two ends, of which one end extends outside of said metal case to be connected to an external electric terminal and the other end is connected to a corresponding terminal of said drive circuit in said shield case, said conductors being electrically connected in an AC mode through said capacitor means to said shield case;

(f) means (16; 17, 25; 18; 19; 20) for electrically connecting said shielding case to said metal case at a portion selected in an area on said bottom wall of said shielding case between an edge of said bottom wall connected to said one

side wall and an edge of said circuit pattern closest to said one side wall.

2. A thermal air flow meter according to Claim 1, wherein said connecting means (16; 17, 25; 18; 19; 20) is a metal member (16; 17, 25; 18; 19) extending through said shielding case and said metal case.

3. A thermal air flow meter according to Claim 1, wherein said capacitor is formed with a through-hole through which said conductor extends from outside to inside of said shield case so that said conductor is electrically connected in the AC mode through said capacitor to said shield case.

FIG. 1

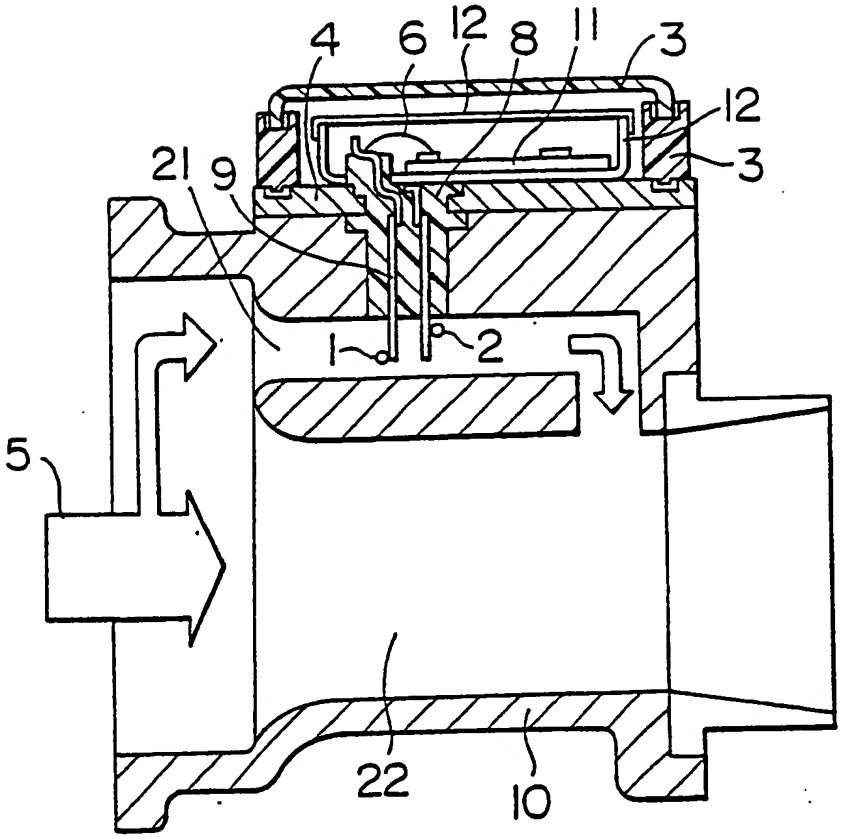


FIG. 2

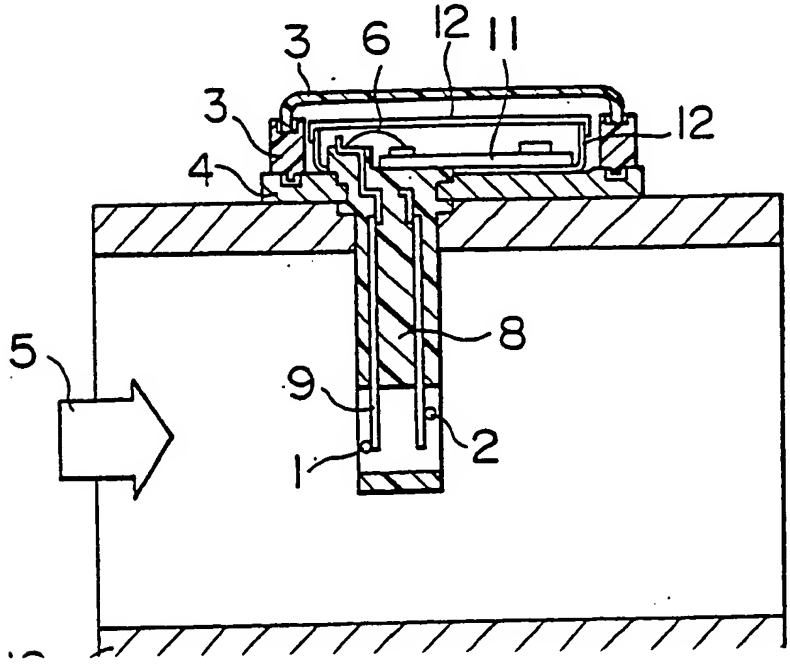


FIG. 3

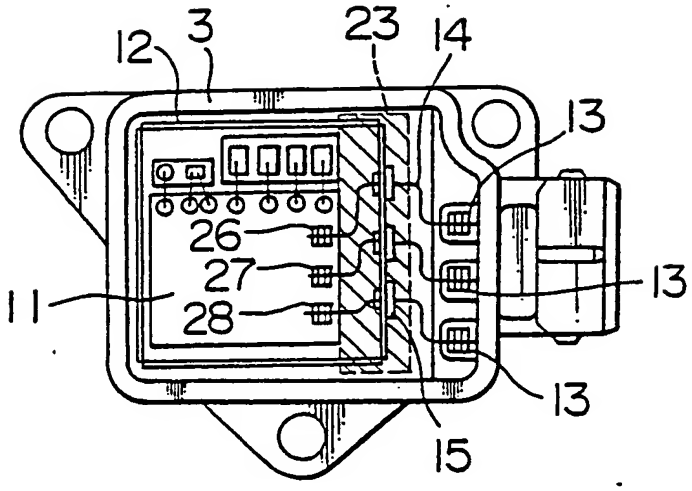


FIG. 4

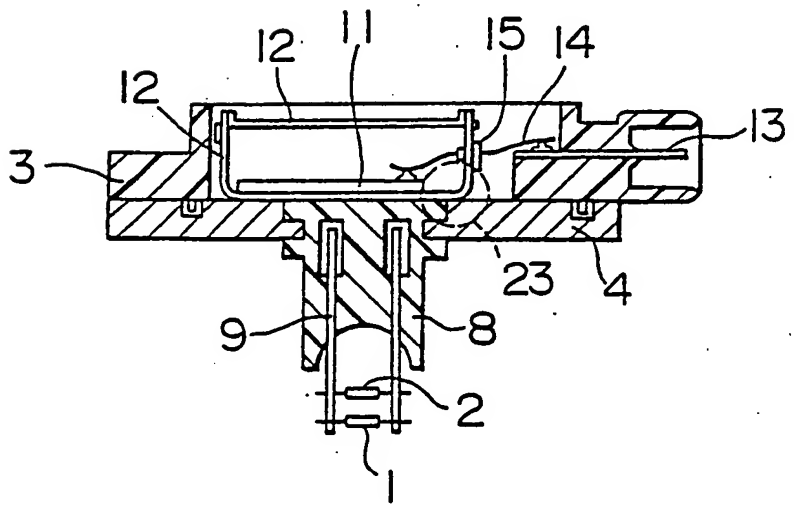


FIG. 5

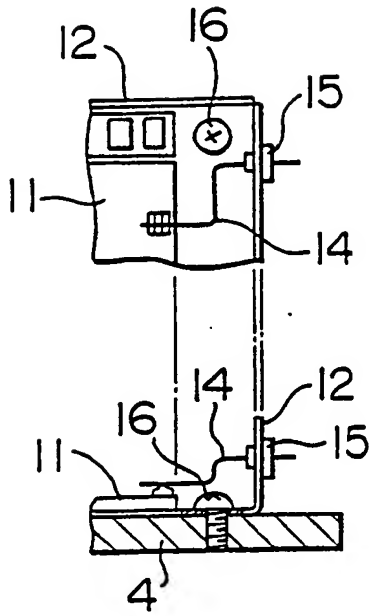


FIG. 6

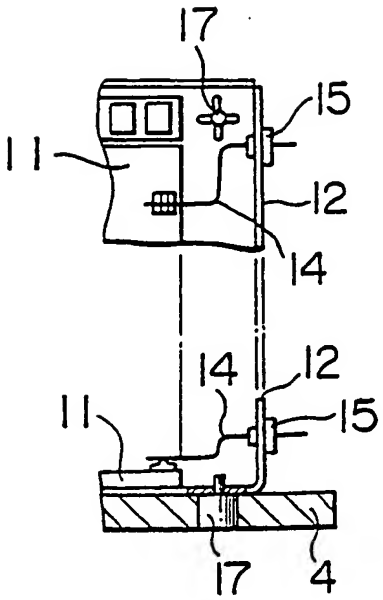


FIG. 7

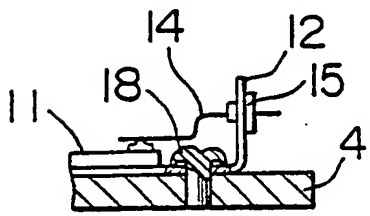


FIG. 8

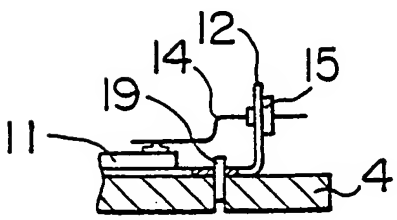


FIG. 9

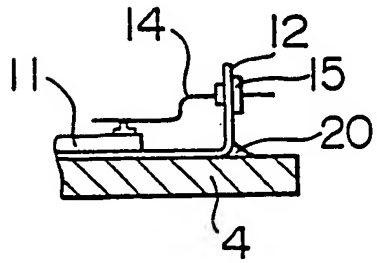


FIG. 10

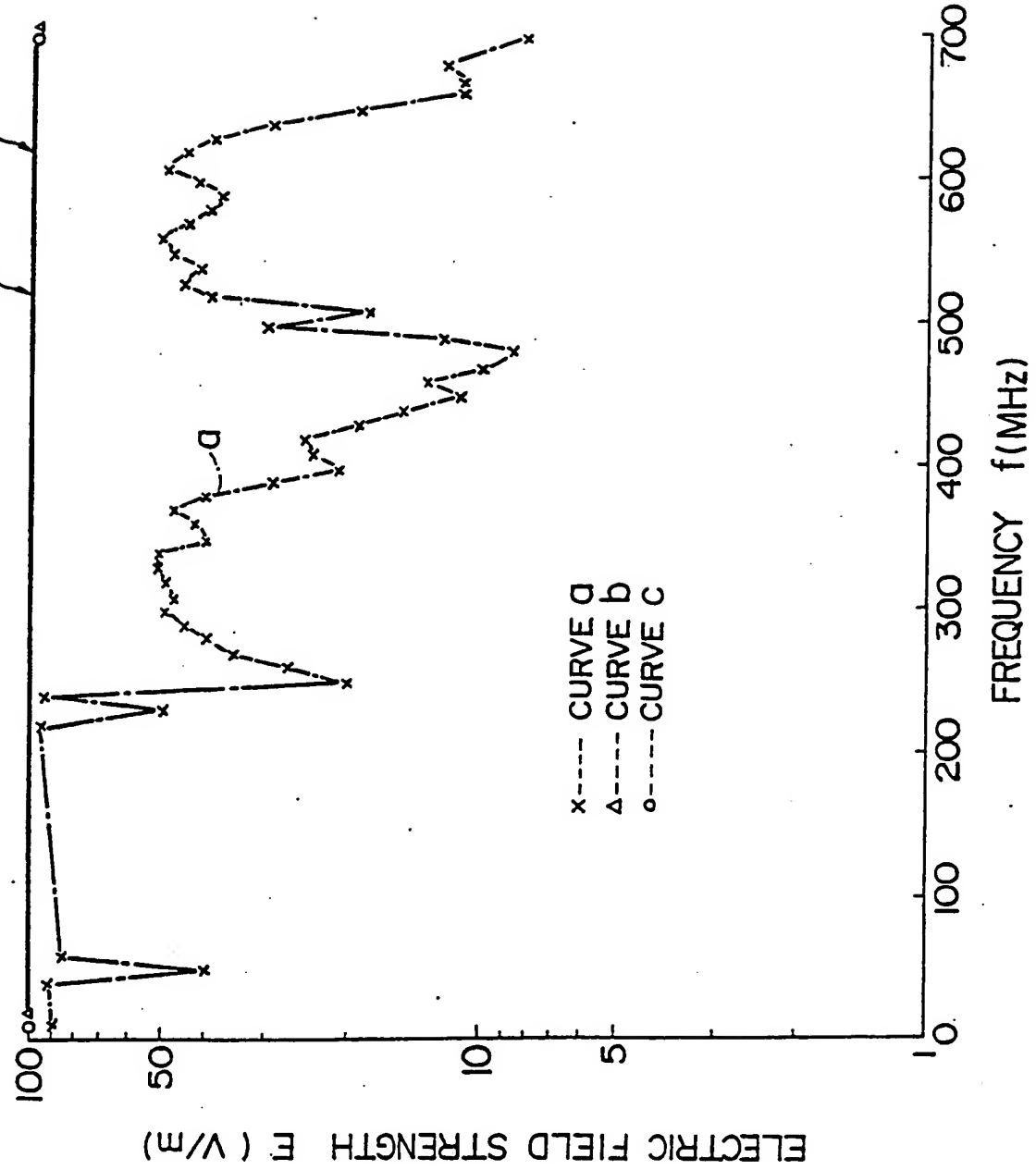

ELECTRIC FIELD STRENGTH E (V/m)
100
50
10
5
1
0
100
200
300
400
500
600
700
FREQUENCY f(MHz)
a
b
c
x---- CURVE a
Δ---- CURVE b
o---- CURVE c

FIG. 11

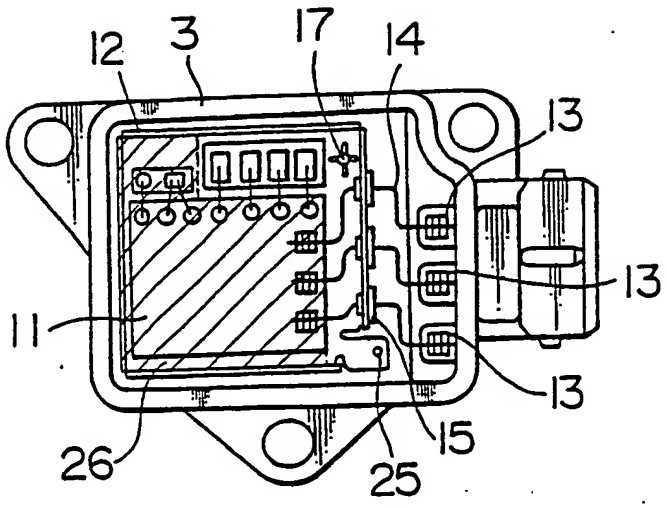


FIG. 12

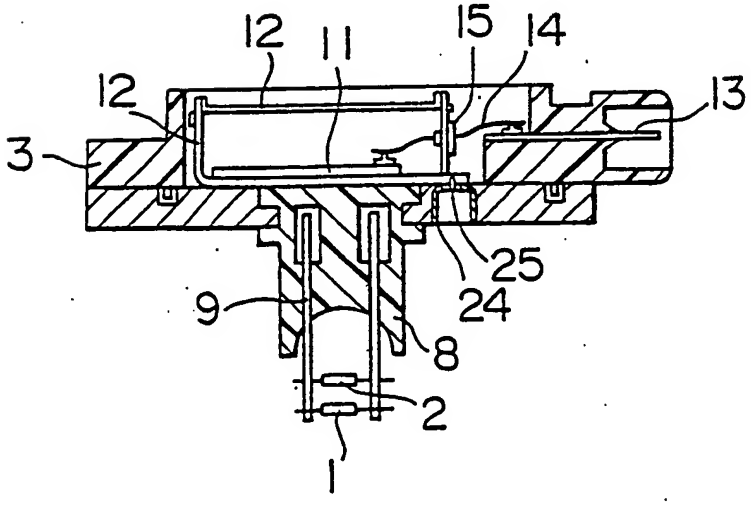


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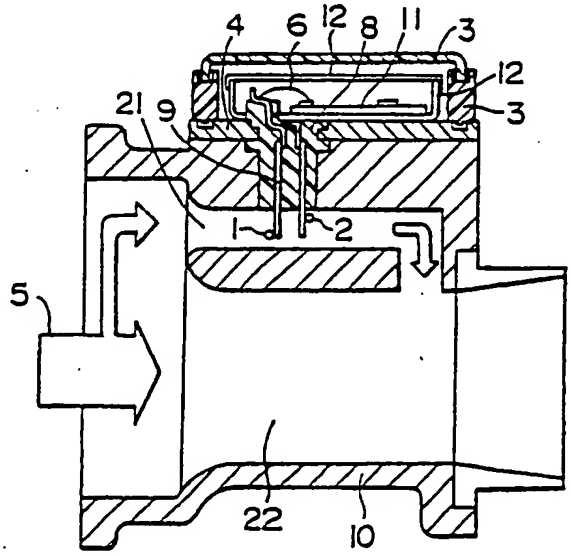
FIG. 1



EP 0 323 694 A3

European Patent Office

EUROPEAN SEARCH REPORT

Application number

EP 88309297.5

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl 4)
A	US - A - 4 386 388 (SEVN) * Abstract; fig.; column 1, line 57 - column 2, line 5 * --	1	G 01 F 1/68
A	US - A - 4 658 334 (MC SPARRAN et al.) * Abstract; fig. 2; column 1, lines 36-41; column 2, lines 34-43; column 3, lines 16-55 * --	1	
D,A	PATENT ABSTRACTS OF JAPAN, unexamined applications, section P, vol. 7, no. 75, March 29, 1983 THE PATENT OFFICE JAPANESE GOVERNMENT page 121 P 187 * Kokai-no. 58-6 414 (MITACHI) * ----	1,3	

TECHNICAL FIELDS SEARCHED (Int. Cl.4)

G 01 F 1/00

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
VIENNA	27-07-1990	FIALLA

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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T : theory or principle underlying the invention
E : earlier patent document, but published n, or after the filing date
D : document cited in th application
L : document cited for other reasons

& : member of the same patent family, corresponding

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